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# Early Childhood Education through Gamification

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**Abstract**—Early childhood education through gamification provides a wholly new environment to students. For this reason, compelling opportunities are set to accomplish the challenging goal for educators/teachers. Hence, in early childhood critical thinking and assessment competencies, is involved to promote the efficiency and mainstream education of gamification. Therefore, this paper aims to decide the effect of personal development in early childhood years that are helpful in gaining knowledge in the classroom and out of the classrooms of pre and primary students' overall performance. The current research aims to prove the significance of gamification and its existing knowledge of gear right into a teacher's coaching technique by upgrading the student's overall performance. The only way to practice digital methods in the study of students and achieve the objectives

of the efficiency model, this paper investigated the learner's autonomy, learning environment, and compelling outputs in students' academic performance. The design of this research is experimental. For this experimental investigation the overall academic performance of pre and primary students was accessed by using the digital gamification learning based model. Hence, random samples from five institutes were used to collect the data for the further analysis. In these selected five institutes three were the boys' school and 2 were the girls' school. Thus, this study targeted the use of gamification in the educational institutes and its effects on the pupil achievements. To measure the performance of the children by using the formula of effectiveness and efficiency this study aimed to investigate the outcome of model

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**enforcement in educational curriculum.**

***Index Terms-* gamification, primary, pupil, gaining.**

## **I.Introduction**

### ***A. Background of study***

Gamification has a high impression on children development, socialism, socio-economics, and on academic success. Early childhood education is a critical and most important stage of children where they acquire and develop their social and cognitive skills, self-esteem, and perceptions. It also significantly impacts the socioeconomic and personality outcomes of the individuals [1]. Early childhood education is a very important and basic stage of learning for the pre and primary students. It also has a significant impact on the whole life of children in building their social cognitive skills set to improve the thinking ability and enhance their decision-making power to improve their leading ability [2]. Early childhood education plays an integral role in the development of children perceptions which directly define their future goals, motives, and achievements [3].

Early childhood education claimed that learning requires to be attentive, engaged, concept based,

receiving and consolidating information, and giving constructive feedbacks. The main goals of gamifications are to enhance the passion for life learning process, generate abilities, optimize learning, and support socialize behavior of students. [4]. The traditional educational strategies do not respect the above-mentioned basic concepts because it is inadequate in terms of direct/deductive learning process. It decreases the children motivation by not providing the doing-based learning which is also called the fixed- based learning structure. Consequently, the students have no choice but to improve the skills set because their motivation, creativity, and interactive intentions were ignored in the knowledge acquisition process.

It is more difficult to motivate students which are currently living in the rural areas. Some students are deprived of schooling in rural areas due to the challenging survival conditions for instance lack of basic infrastructure, schools located far away from the residential areas, and poverty which also deprives the students of acquiring the basic education. Hence, some families do not know the value of education and are less interested to give education to their children [5]. The challenge is to give and raise awareness in the

rural areas by motivating early childhood education. Hence, learning through gamification for instance play-based or doing-based learning allows students to interact with others in a stimulate environment which maintains and increases their motivation, interaction, and decision-making ability in early childhood [6].

Early childhood education through gamification is the best way to teach children doing based learning process to get their attention and to engage their skills by providing constructive feedback. Early childhood education provides rich variety of doing based activities in a stimulated environment. Hence, by enhancing cognitive skills doing based activities enhance the creativity and learning skills with the experimental knowledge. It also enables the children to improve their capabilities to deal with the real-life situations [7]. Gamification is a practical based education and is a natural way for the child learning process which most likely improve their skills in the early years of life. When students learn through gamification after seeing new things their ability of critical thinking enhances their information and develop the interest about knowledge [8]. Gamification provides learning through playing a pedagogical strategy that is

increasingly used in the educational performance of students which creates a fun learning experience the pupil.

Gamification has improved the quality of early childhood education in these recent years [9]. It has rapidly spread the digital pedagogical material and allowed the teachers and students to access online material.. In this regard the aim of this current study is to use digitalized games-based education on the pedagogical aspects. This paper presented a methodological approach that used gamification play based learning for the early children's educational performance [10].

### ***B. Problem Statement***

Telecommunication is an integral part of reading and writing skills for scholars of 21<sup>st</sup> century. In addition, it is more rigorous and active as compared to training they received at an academic level. This has created a gap between student's learning inspiration and school-based knowledge areas. In order to meet the upcoming demands of global economic growth and urge student to constructively participate as a member of an independent society, a collective effort is required on academic level to transform classrooms. In order to resolved this, a new gamification

has been introduced as research literature shows that gamification has creative potential that promotes learning environments. It develops a better realizing of the effect and potential influence of game-based education on learners.

### ***C. Research Objectives***

1. To infuse gamification for gaining knowledge and achieve better results in schools in order to enhance the usage of digital studying and talents improvement.

2. To urge students to use gamification for learning in the study rooms and on the domestic levels.

### ***D. Research Questions***

The selected questions guide this study:

1. Does the role play of gamification affect the academic performance, engagement, and thinking capabilities of students?

2. How motivational design affects the inspiration, pronunciation accent, and deep learning of the pre and primary students?

3. To identify the student recommendations after considering their experiences of gamification?

To answer the above research questions, the current study aims to

consider students views regarding their experience of gamification, inspirational knowledge, and interactive communication that resulted in the recommendation of gamification for learning and academic purpose.

### ***E. Signature of the study***

The researcher declared after the investigation that childhood education through gamification increases the students' engagement, motivation, deep learning, thinking capabilities, personal development, academic performance, and long-term learning. The researcher also indicated that teachers have observed and confirmed the use of academic strategies through gamification which resulted in difficulty in preparing their lectures and teaching strategies which were already fine. Moreover, the researcher also indicated that these new lecturers would enable students of pre and primary school in enhancing their capacity through the gamification curriculum.

## **II.Literature Review**

The resolution of this acquired education was to estimate the effect of gamefic thinking on the inner inspiration and on the academic appearance of pre and primary school students. The review of

related texts is based on the research questions given below.

(a) How the game modification affects the inner motivation of the students?

(b) Whether game modification affects the academic performance of students or not?

(c) What recommendations students could make after meditating their knowledge of gamification?

The loosely based and minimal research on gamifications ended in non-essential results and diffusing terms like 'make a game' or 'gamification.' However, combining variables like keywords (e.g., "gamely thinking AND inspiration") may limit the search until other relevant studies are published. Hence, the term 'gamification' was selected to confirm the examination of this rapidly increasing subject, which encompasses a wide spectrum of gamify and includes words like gamifying, gamified, and fun. Early childhood education source data was used to conduct preliminary searches [11]. Throughout the remainder of 2017, programs were chosen, sorted, and updated based on their dynamic relationships in the primary listed research questions. Therefore, the selected topics were then dredged

up in order to leverage references to identify other sources, such as books, websites, films, and articles not originated in the previous searches [12]. For this in this literature review several selected books have been reviewed, later in these studies it is argued that a social approach is significantly required in constructing the educational instructions which is an essential beneficial impact for the students' internal motivation and academic performance. [13]. The above-stated argument is based on current study's literature review, which includes theory and research efforts. The updated literature is divided into three parts. The first section covers the meaning of gamification, as well as its components (e.g., mechanics, aesthetics, and so on). Further it differs from associated concepts like game-based education and tough games [14]. The additional sections define the emerging concept of gamified reading and assessments, the gamification proposal, and its frameworks [15]. It compares gamification to behaviors of students as well as social methods of improving gamification and summarizes outstanding motivation frameworks initiate in existing research biography. The outcomes of this research aim to analyze the gamely designs and inner inspiration, academic achievement,

and scholar kinds, individually, make up one-third of the study [16].

### ***A. Gamification Definitions***

Gamification isn't really a novel notion in many ways. Throughout the recorded history, people have utilized games, game components, and theaters to motivate, engage, and teach pupil [17]. Soldiers and establishments for example the Boy Scouts issue symbols for remarkable performances of daring and ability; international firms design games like Control to enhance customer assignation and improve sales. Various aspects of game could be found in practically every part of life, both past and current – challenges, cooperation, prizes, rules, narratives, and so on [18]. This raises the question of what distinguishes gamification as a fresh albeit minor notion. To answer this question, the first thing that must be comprehend in the word's origin and context is the adaption of the use of gamification digital model. [19]. Although, some researchers have pointed out that the term "gamified" has been used in textbooks several times to discuss the learning impact and outcome of gamification digital model.

### ***B. Motivational Frameworks for Gammification***

The concept of incentive in over-all and fundamental inspiration in precise, is essential to a sociocultural approach of gamification. The goal of this section is to provide a quick overview of the significant motivating theories and frameworks that have been utilized in the literature review to explain and design the gamified learning systems. For this purpose, this current study incorporates the flow theory, self-determination theory (SDT), the ARCS model, and the intrinsic motives taxonomy in particular.

### ***C. Flow Model***

Flow model defines the spiritual state of existence entirely involved in an action. This implies that the work would be of optimal difficulty because if the model is simple then the developed actor will appear tired and lose flow. On the contrary, if the model is overly complex, the developed actor will seem anxious and miss movement [20]. Flow combines action and awareness, focusses attention, loses ego, controls act and surroundings, difficulties deed and unambiguous criticism. and is autotelic. While generating a boost in a gamification knowledge environment is difficult,



it can provide designers with a structure and a goal. Furthermore, the current research suggests that in a gamified workplace, the conditions for flow are very critical and impactful for the learning outcomes.

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#### ***E. Self Determination Theory***

The utmost extensively utilized inspirational background in gamification study is the self – determination theory (SDT). According to SDT, individuals have a usual proclivity for dynamic, self-inspired, and self-controlled behavior [21]. Excessive control, non-optimal difficulties, and a lack of connectedness would sap an individual's intrinsic drive, whereas experiences that increase emotions of capability and self-purpose would boost it.

#### ***F. Classification of Intrinsic Inspirations***

The intrinsic inspirations motives classification and are incorporated in the current study. Hence, the findings of the selected motivating factors of sports distinguishes between the inner and relational incentives. In the following paragraphs the taxonomy's categories are discussed which give relevant empirical studies to support the intrinsic inspiration.



*Internal Incentives\_* includes control, challenge, fantasy, and curiosity.

*Challenge\_* The terms of specific challenge inspiration, suggested that an action must deliver clear goals with unknown outcomes, as well as presentation response that is directly linked to the objective achievements and are helpful for the beginners' self-esteem. When they discovered that just presenting an action like a game linguistically with objects was as emotionally successful in raising intrinsic inspiration as the "deep gamification" learning process.

*Curiosity\_* is inspired by two different sorts of environmental cues: sensory and cognitive. The aesthetics of games are linked to the sensory inquiry. On the other side, cognitive curiosity is linked to the concepts of inquiry and the need for coherence, or what usually is called "well-formed cognitive structures."

*Control-* It linked the concept of control to a person's need for self-determination, arguing that learning settings should empower students through their perceptions of control. Contingency (the belief that a single's consequences are dependent on a single's answers), optimal, and strength could help to support this perspective.

*Fantasy\_* Arguably, it is believed that imagination is a significant contribution to essential inspiration. Despite the fact that it is rarely regarded in terms of intrinsic motivation. They distinguished between exogenous fantasies and endogenous fantasies. Endogenous fantasies, according to this argument, are further active because they offer a particular constructive response, images for learning ideas, and actual applications.

*Interpersonal Motivations-* Cooperation, competitiveness, and recognition are all interpersonal motivators. While some of these motivators are obviously extrinsic, others might give 45 internal inspiration which would not occur lacking the existence of and contact with further people.

*Cooperation\_* Emphasize the importance of characteristics between dependent and independent elements of communications while creating learning environments which encourage collaboration. While independent units do not want students to rely on others, dependent units require students to collaborate extensively with others.

*Competent\_* Exogenous rivalry could boost inspiration briefly, but it could also get detract from intrinsic motivation in the long run. Endogenous competition, like

cooperation, can be aided by dependent units of interaction. Inter-team race was found to be additionally inspiring for contestants than teamwork or separate rivalry in recent field research of the gamification technique.

*Recognition*—The last sort of intrinsic motivation that is discussed in this current study is recognition. Acknowledgement of one's accomplishments is a required standard for knowledge surroundings which get inspiration through acknowledgement. Leaderboards, symbols, and player objects are examples of different kind of acknowledgment in a gamified learning environment.

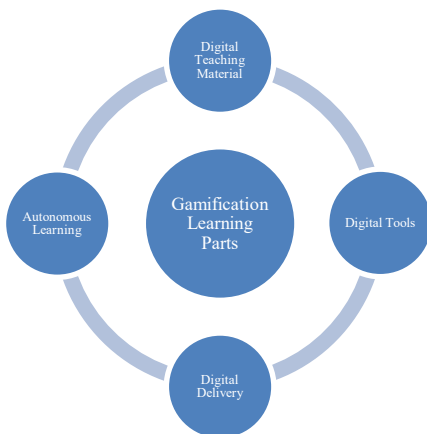


Fig. 1. Gamification learning parts on early childhood education

## G. Context and challenges

Incorporating digital technology into education and motivating digital learning must need a specific educational context which could only be acquired through teacher's active participation [22]. The discrepancy between aspirational expectations and actual outcomes is attributed to demanding situations that arise as a result of a variety of influences on teachers who are attempting to convert their teaching practices. In this current study, the term "influences" is used instead of the most commonly used term "barriers" to acknowledge that not all encouragements are hurdles, and some are likely enablers. Hence, the effects of gamification on early childhood education are depicted in Fig. 1.

## H. Extrinsic Influences

First-order obstacles are described by extrinsic affect. Extrinsic effects are divided into three businesses or agencies: namely, Obtain access to sources, institutional factors, and curriculum and evaluation issues.

## I. Intrinsic Influences

Intrinsic influences are also difficult to approach because they referred to it as a second-order barrier. While integrating the intrinsic effect on teaching

practices, the digital network is dominant and difficult. Intrinsic influence is the proper gatekeeper

that enables a teacher to analyze the cognitive skills of students [23]. Intrinsic impact is further divided

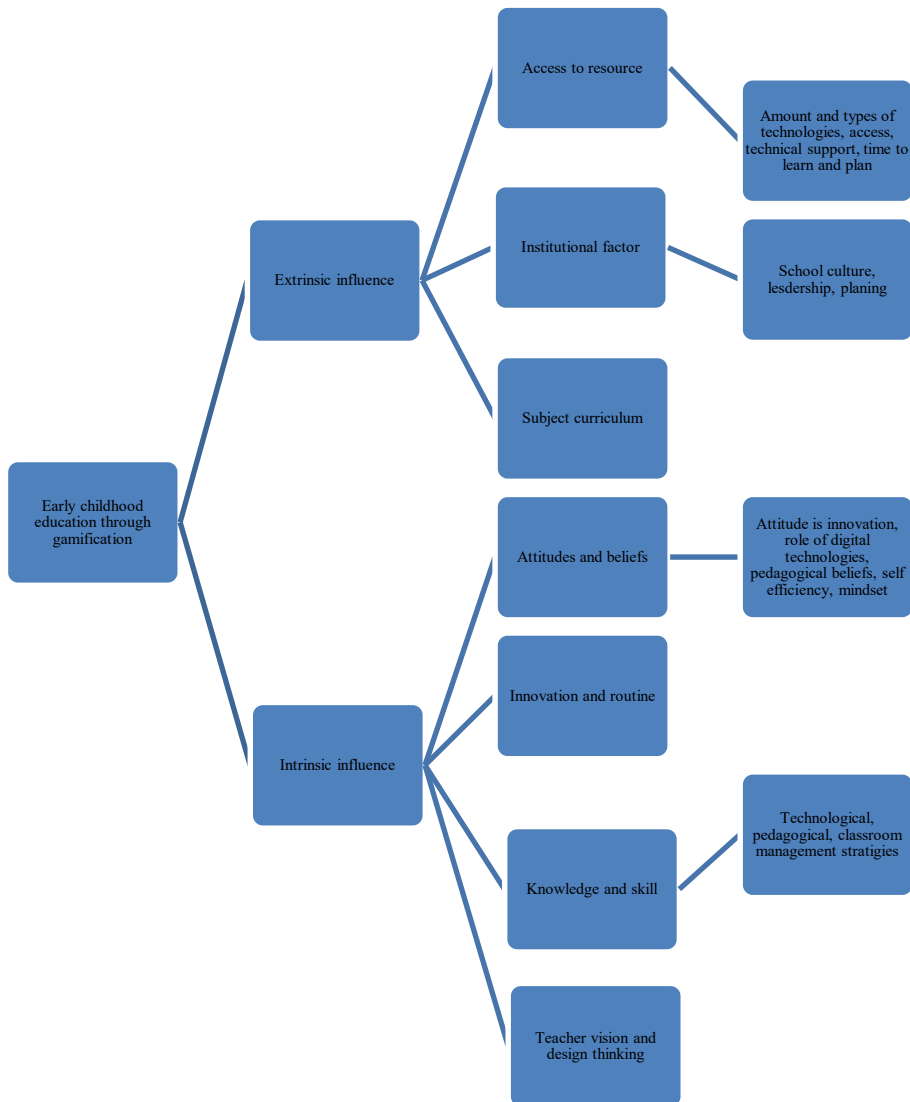


Fig. 2. Extrinsic and intrinsic impacts of gamification on early childhood education

into four categories, each of which includes features that happen within the individual instructors. The four categories are mindset and opinions, innovation and routine, competencies and expertise, imaginative and prescient, and proposal thinking (seek advice from fig 2).

### **III. Research Methodology**

#### ***A. Research Design***

Gamification is most significant in early childhood education in which the researcher could work to increase the performance of the students. The points which were used to enhance the output of children's and created an impact on them in this paper were intrinsic motivation, extrinsic motivation, deep learning, long term learning outcomes, positive impacts, enhance thinking capabilities, enhance student engagement, sharp problem-solving skills, able to think differently, improve reading and pronunciation, and personal development. Hence, some finalized points that are most valuable for enhancing the early childhood education via gamification were intrinsic and extrinsic motivation, long term learning outcome, improve pronunciation, sharp problem-solving skills, and enhanced thinking capabilities.

#### ***B. Population***

It's critical to comprehend the study's targeted groups so that we could figure out who or what the data refers to. So, for these purposes the selected population for this current study is the pre and primary-schools. Furthermore, some schools have been randomly selected for this purpose in which three were (3) boys' school and two (2) were girls' schools. There are, of course, certain drawbacks considering the studying populations. As a result, this study utilized statistics to research subpopulations and collect statistical samples of small segments of larger groups in order to properly examine the whole range of behaviors and traits of the general population.

#### ***C. Sample and Sampling Techniques***

The sample of this current research work based on five (5) schools which were selected randomly. There were three (3) male and two (2) female's schools selected for this purpose. Two hundred Thirty-two (232) students were selected to analyze their higher and lower performance. All the students belong to the pre and primary schools. Simple random sampling technique was used in this situation, each person is picked

randomly by chance, and every member of the selected population has an equal chance of being chosen.

#### ***D. Data Collection***

Each person is chosen randomly in this case and every member of the population has an equal chance of being chosen.

#### ***E. Experiment***

1) *Group A*: Task (enhances pronunciation and accent): in this task individual devices were given to students of group A and they learnt from it. Some students which are not able to pronounce the word after listening it once they used the button to pronounce again even then they were able to learn it. Some students took short time and some took extra time but all of the pupil were able to learn clear accent by using gamification technique.

2) *Group B*: Task (long term learning): using gamification in early childhood education learning is a long term pictorial presentation of things stored in the memory of a child for longer time. The colors, background, and examples that are used in gamification are used in daily life. It makes the students learning useful and easy to understand.

3) *Group C*: Task (making students able to think differently/creatively): using gamification concept in some situations given inspiration to students, they select the answer by using previous knowledge and using their own thinking capabilities like short comprehensions, reading them, and giving answers of the required questions, so in this case students would use their own thinking capabilities. In this way gamification enables students to think differently.

4) *Group D*. Task (enhance engagement): in this task gamification is used to enhance the engagement of children. In this current time period gamification is a new and unique technique for the learning of children which learn through singing, games, and other fun activities. Children's took more interest in their education by using gamification in studies. So, in this way gamification is a active learning technique for student's engagement.

The records have been analyzed by using usability evaluation numbers to test the momentous modifications due to the one-of-a-kind educational technique.

Table I

## Sample groups and tasks for experiments

Groups	Tasks	Sub-tasks	Total participants	Total time (min)	Task status	Post task evaluation
Group A (female and male)	Enhance pronunciation accent	60 words	45	45 max Time taken	34 students completed task in given time	ASQ
Group B (female And male)	Able to think differently	Clear concept enhances ideas perform 2 activities	45	20	30 36	ASQ
Group C (female And male)	Long term learning	Words store in memory for long time perform 2 activities	45	1800	40 42	ASQ
Group D (female And male)	Sharp problem-solving skills	Able to create solutions perform 2 activities	45	05	29 31	ASQ

**F. Usability Evaluation**

Performance of usability measures is analyzed by using three parameters that are efficiency, effectiveness, and satisfaction. Unintentional actions, slips, blunders, or omissions made by a user while attempting a task are

examples of errors. Effectiveness is defined as the number of goals achieved divided by the number of the total people involved.

$$\text{Effectiveness} = \frac{\text{Total number of tasks completed successfully}}{\text{Total number of tasks undertaken}} * 100$$

The resources such as time, money or mental efforts that have to be extended to achieve the intended goals; called efficiency and can be measured as:

$$\text{Time based Efficiency} = \frac{\sum_{j=1}^R \sum_{i=1}^N \frac{n_{ij}}{t_{ij}}}{NR} \quad (2)$$

Where

N = The total number of tasks (goals)

R = The number of users

$n_{ij}$  = The result of task i by user j; if the user successfully completes the task, then  $N_{ij} = 1$ , if not, then  $N_{ij} = 0$

$t_{ij}$  = The time spent by user j to complete task i. If the task is not successfully completed, then time is measured till the moment the user quits the task

Satisfaction is measured by the product which is acceptable. Usability is dependent on the context of the product used in the specific circumstances. Satisfaction is measured through ASQ technique in this paper. It also contains some point scale questions (strongly disagree=1, disagree=2, somewhat disagree=3, neither agree nor disagree=4, somewhat agree=5, agree=6, strongly agree=7). It shows the aspect ease of task completion, time to complete task, and analyze the satisfaction level.

#### IV. Results and Discussion

The effectiveness, efficiency, and satisfaction of four common features have been calculated, including improved pronunciation, the ability to think differently, in long-term learning are keen problem-solving skills. Three usability factors are used to illustrate the results.

The effectiveness in the usability to enhance pronunciation accent demonstrated overall average of the students which used gamification. By using non gamification some students did not take fully interest in the class so they were not able to learn properly and the average of these students is shown in Figure3. Learning via gamification is interesting for the students and a total new experience which enabled them to learn properly with full interest. The results are shown in Figure3.

Gamification is providing a wide range of concepts and other related things so in this way students could see different things and broader their critical thinking ability. Hence, with the passage of time, they would be able to think differently, for this the results are shown in Fig. 3.



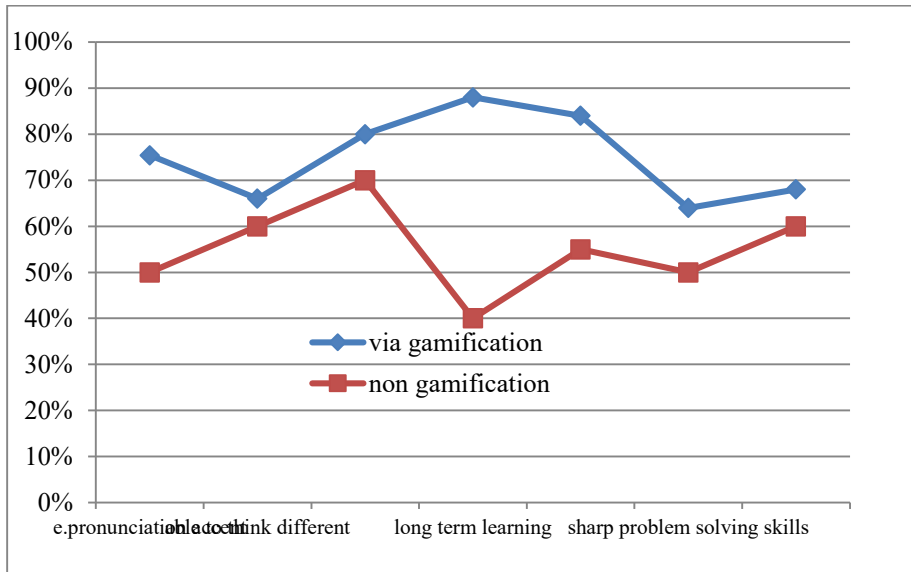


Fig. 3. Effectiveness a) Activities e Experiment

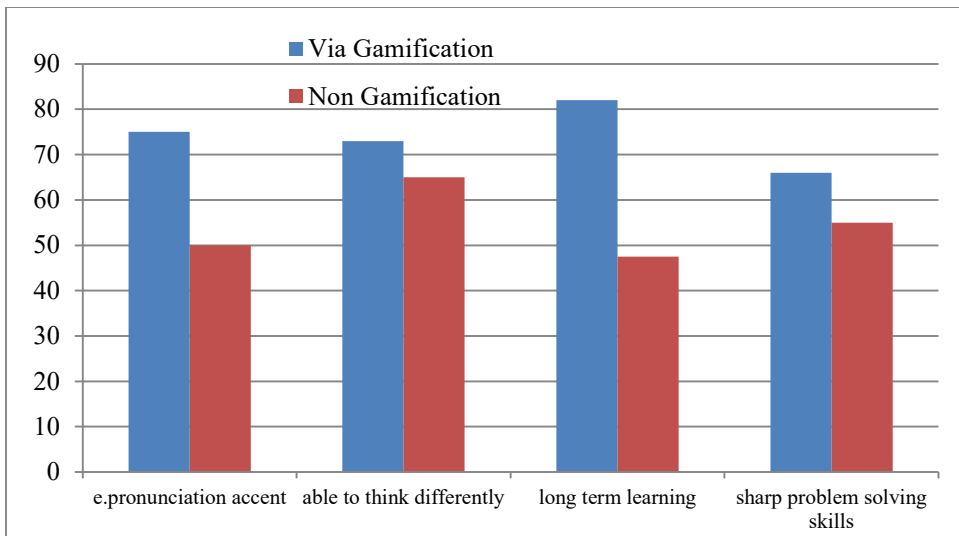


Fig 4. Experiment results average

In this chart, the average results of the experiments are shown which highlights that the conducted

experiments of this paper enhanced pronunciation accent and the results of this experiment are

shown in the chart that expresses 75% children's were able to enhance their pronunciation/accent while the students that were not using gamification the results were relatively low than 50% which is lower than the gamification. So in the chart listed below the overall results are shown which highlighted that the performance of the students

via gamification is better than the performance of the students that were using non-gamification. Gamification provides victorious views by enabling a child to take more interest in this form of study. Another advantage of gamification is that the child repeats the lesson but in the classroom this option is not available.

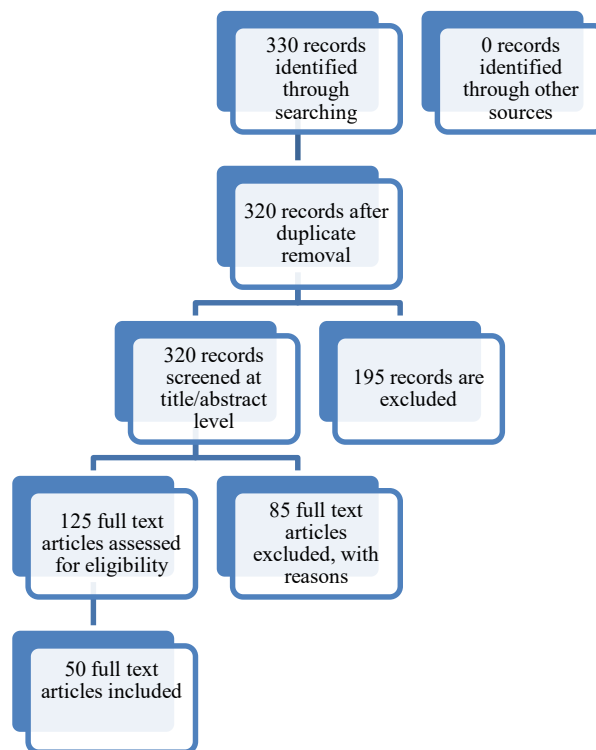


Fig 5. Flow diagram of total articles and after excluding, included articles

## V.Conclusion

This paper aims to investigate early childhood education through gamification. Some facts depicted

through tables indicate that gamification is better than other ways of learning. Gamification enhances student's motivation by

using icons, badges, and scoring points. By conducting this activity-based learning they all tried to gain more points so in this way they learned new things which increased their academic performance. Furthermore, this paper also described that learning through gamification is a long term- pasting of pictures of various things, which also has a longer impact on the memory of children. Learning through gamification is also a deep and practical-based learning which is useful as shown in the Tables. Early childhood education through gamification has also significantly enhanced the thinking capabilities of the students. It also polished the socializing abilities of students by the interactions made by the students. Consequently, pupil learned through gamification without any burden they felt happy and burdenless. This new implementation of gamification strategy also enhanced the engagement of the students by enabling them to think critically and creatively through which they developed problem-solving skills. Hence, as a result, gamification improved the academic performance and personal development of pre and primary school students.

## References

- [1] R. Andrews, "Where next in research on ICT and literacies?" *English Educ.*, vol. 37, no. 3, pp. 28-41, Sept. 2003, doi: <https://doi.org/10.1111/j.1754-8845.2003.tb00603.x>
- [2] W. Mougayar, *The business blockchain: Promise, practice, and application of the next Internet technology*. John Wiley & Sons, 2016.
- [3] P. F. Bassett, "Reengineering schools for the 21st century," *Phi Delta Kappan*, vol. 87, no. 1, pp. 76-83, Sept. 2005, doi: <https://doi.org/10.1177/003172170508700112>
- [4] K. Ibacache, A. Rybin, and E. Vance, "Emergency remote library instruction and tech tools: A matter of equity during a pandemic," *Inf. Technol. Lib.*, vol. 40, no. 2, June 2021, doi: <https://doi.org/10.6017/ital.v40i2.12751>
- [5] H. J. Becker, "Findings from the teaching, learning, and computing survey," *Education Policy Analysis Archives*, vol. 8, pp. 51-51, Nov. 2000, doi: <https://doi.org/10.14507/epaa.v8n51.2000>

- [6] T. S. Dee and B. Jacob. "The impact of No Child Left Behind on student achievement," *J. Policy Anal. Manage.*, vol. 30, no. 3, pp. 418-446, May 2011, doi: <https://doi.org/10.1002/pam.20586>
- [7] E. Byrom, *Review of the professional literature on the integration of technology into educational programs*. Durham, NC: Southeast Initiatives Regional Technology in Education Consortium, 1998.
- [8] R. Young, "Using technology tools in the public-school classroom," MS thesis, Graduate Sch., Univ. Wisconsin-Stout, Menomonie, USA, 2008.
- [9] M. Hennink, I. Hutter, and A. Bailey, *Qualitative Research Methods*. Sage, 2020.
- [10] V. Kapila and M. Iskander, "Lessons learned from conducting a K-12 project to revitalize achievement by using instrumentation in Science Education," *J. Sci. Technol. Eng. Math Educ.*, vol. 15, no. 1 Apr. 2014.
- [11] C. Koziol, *Teaching 'the City' in Cities: Teasing the Global from the Specific in Chicago*. Association of Collegiate Schools of Architecture, 2011
- [12] B. Means, *Using technology to support education reform*. US Department of Education, 1993.
- [13] N. Postman, *Technopoly: The surrender of culture to technology*. Vintage, 2011.
- [14] J. M. Roschelle, R. D. Pea, C. M. Hoadley, D. N. Gordin, and B. M. Means, "Changing how and what children learn in school with computer-based technologies," *Future Children*, vol. 10, no. 2, pp. 76-101, 2000. <https://doi.org/10.2307/1602690>
- [15] R. E. Cimera, "The economics of supported employment: What new data tell us," *J. Vocat. Rehabil.*, Vol. 37, no. 2, pp. 109-117, 2012, doi: <https://doi.org/10.3233/JVR-2012-0604>
- [16] D. Hansen and L. A. Imse, "Student-centered classrooms: Past initiatives, future practices," *Music Educ. J.*, vol. 103, no. 2, pp. 20-26, 2016.

- [17] L. Archambault, H. Leary, and K. Rice. "Pillars of online pedagogy: A framework for teaching in online learning environments." *Educ. Psych.*, pp. 1-14, June 2022. <https://doi.org/10.1080/00461520.2022.2051513>
- [18] M. Sbaraglia, M. Lodi, S. P. Zingaro, and S. Martini, "The Good, The Bad, and The Ugly of a Synchronous Online CS1," in *proc. 26th ACM Conf. Innova. Technol. Comput. Sci. Educ.*, Germany, July 2021, doi: <https://doi.org/10.1145/3456565.3460075>
- [19] G. Tapia-González, R. Martínez-Gutiérrez, and F. Tapia-González, "Hackathon-Edu: a global competitiveness perspective," Presented at the *Int. Conf. Intell. Hum. Syst. Integ.*, Cham, Netherlands, 2021.
- [20] M. K. Shomirzayev, "Developing educational technologies in school technology education," *Next Sci. Conf.*, vol. 1, no. 1, pp. 14–23, 2022.
- [21] H. C. A. Kistoro, C. Setiawan, E. Latipah, and H. Putranta, "Teachers' Experiences in Character Education for Autistic Children," *Int. J. Evalu. Res. Educ*, vol. 10, no. 1, pp. 65-77, Mar. 2021.
- [22] C. N. Giannikas, "Interactive whiteboards in EFL from the Teachers' and students' perspective," *Res. Papers Lang. Teach. Learn.* vol. 11, no. 1, pp. 203-219, 2021.
- [23] S. Ghory and H. Ghafory, "The impact of modern technology in the teaching and learning process," *Int. J. Innov. Res. Sci. Stud.*, vol. 4, no. 3, pp.